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“The dynamics of IP contract patterns in the German biotechnology industry – a mixed-methods approach”

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Abstract

Academic spin-offs play a pivotal role in leveraging the economic potential of scientific discoveries by transferring research results into marketable technologies, products, and services. The creation of a spin-off is frequently formalized through an intellectual property (IP) contract between the research institution and the new venture, which establishes the foundation for the spin-off’s initial growth. While the broad impact of research institutions on IP contract patterns is acknowledged, further investigation is required to ascertain the specific effects of their individual preferences. Furthermore, country-specific characteristics influence technology transfer practices. However, the lack of empirical data on IP contract patterns in research-intensive nations, such as Germany, impedes a comprehensive analysis. This study examines the impact of the individual risk and reward assessments of German public research institutions on the design of IP contract patterns. A sequential mixed-methods approach is employed, starting with a survey of biotechnology spin-offs to collect empirical data on IP contract patterns. This is complemented by semi-structured expert interviews with technology transfer managers to triangulate the survey data and gain insights from the perspective of the research institutions. Our findings suggest that the observed heterogeneity in IP contract patterns can be attributed to the varying risk and reward assessments of research institutions. The resource-based view allows us to demonstrate that these variations arise from institutional preferences regarding the transfer of IP ownership versus licensing IP to spin-offs and accepting spin-off equity and/or cash compensation. The resource-based considerations in question vary between universities and non-university research institutions and are shaped by the individual IP strategies and resource endowments of each.

Keywords Technology transfer · Spin-offs · Intellectual property · Contract patterns · Fundraising · Risk assessment

1 Introduction

Policymakers are increasingly emphasizing the importance of commercializing scientific results generated in public research institutions (PRIs) (Ambos et al. 2008; Philpott et al. 2011). Commercializing research results is a means of translating investments in public research into impact at the corporate and societal level (Fini et al. 2019). Among the various transfer pathways, academic spin-offs play an essential role in the transfer of research results into technologies, products, and services (Fontes 2005). In particular, high-tech industries such as biotechnology or information technologies are strongly associated with spin-off activities (Bonardo et al. 2010; Wright et al. 2006). Spin-offs thus contribute to job creation, innovation, and productivity growth in the high-tech sectors of knowledge-based economies (Block et al. 2018). In order to exploit the commercial potential of scientific results through spin-off creation, the legal framework in several countries requires the negotiation of an intellectual property (IP) contract between the PRI and the spin-off's founding team. In countries with institutional IP ownership, such as the US, the UK, or Germany (Fini et al. 2017), the PRI owns the underlying IP. Consequently, the development of spin-offs is initiated and in their early stages influenced by the terms and conditions of the IP contract (Fini et al. 2017; Macho-Stadler and Pérez-Castrillo 2010; Rasmussen and Wright 2015; Wright et al. 2006): For example, the IP contract's terms of payment determine how the spin-off remunerates the PRI for the licensing or transfer of IP ownership and thereby influence the spin-off's cash flow and/or cap table. Also, deviating expectations between PRIs and prospective spin-off investors regarding IP ownership affect spin-off fundraising.

Different IP contract patterns influence the early development of spin-offs to varying degrees, yet several research gaps call for further investigation. This study attempts to fill gaps in the literature by examining the influence of PRI preferences on IP contract design and provides insights into transfer mechanisms beyond university IP licensing. Firstly, while Aksoy and Beaudry (2021) have recently argued that IP contract patterns vary depending on the resource-base of the licensee, they did not account for the preferences of the research institutions themselves. Although Aksoy and Beaudry (2021) generally acknowledge the variability of the PRIs' preferences, they assume that these preferences are relatively homogenous. Yet, rather than examining spin-off preferences to promote technology transfer, recent discussions in Germany and the UK target the different preferences of PRIs, weighing the benefits of standardized terms and calling for more transparency regarding IP policies (Kulicke 2023a; Tracey and Williamson 2023). Therefore, questioning the assumption and exploring the mechanisms that drive IP contract heterogeneity from the PRIs' perspective contributes to a data-driven discussion on promoting technology transfer by factoring in the preferences of the IP owner. Secondly, prior literature focuses predominantly on IP licensing (Doran et al. 2024) and pays little attention to the transfer of IP ownership. Similar to Aksoy and Beaudry (2021), previous research generally assumes that IP ownership remains with the PRI (Jensen and Thursby 2001; Savva and Taneri 2015). This one-dimensional perspective on IP contract patterns is insufficient as potential spin-off investors are known to often prefer the transfer of IP ownership to the venture (Wright et al. 2006). Failure to consider investor preferences

for transferring IP ownership is a shortcoming in the study of technology transfer practices, particularly when insufficient funding threatens to impede the commercialization of research results. The transfer of IP ownership introduces a second dimension of heterogeneity in IP contracts (Kulicke 2023a; Wright et al. 2006) that requires further investigation due to its influence on subsequent spin-off fundraising. Thirdly, existing studies primarily examine technology transfer practices of universities (Siegel et al. 2023; Woolley 2017), while differences between universities and non-university research institutions are to be expected. In Germany, for example, the regulatory framework of IP ownership at universities was only established in 2002, while non-university research institutions have been operating within this framework for several years (Kulicke 2023a).

To address these research gaps, we investigate how the individual risk and reward assessments of German public research institutions influence IP contract patterns. Country-specific technology transfer characteristics, such as regulatory frameworks (Aksoy and Beaudry 2021; Fini et al. 2017; Geuna and Rossi 2011), require country-specific empirical data. While previous literature on IP contract patterns has often focused on the US and the UK, there is little empirical data on countries such as Germany (acatech 2016, Kulicke 2023a). The German biotechnology sector in particular is large enough to meet the criteria for an industry-specific research setting, and thus minimizes industry-specific deviations in contract design. The biotechnology industry represents an ideal research context as IP plays a crucial role in business development (Haeussler et al. 2014). The study employs a sequential mixed-methods research design. First, a survey was conducted among German biotechnology spin-offs to collect empirical data on IP contract patterns. The survey results were triangulated and complemented by semi-structured expert interviews with technology transfer managers from German universities and non-university research institutions, providing deeper insights into the institutions' perspectives on IP contract design. The primary dataset comprises 39 datasets of IP contracts negotiated with German PRIs between 2010 and 2022 and 27 semi-structured expert interviews (see supplementary data in the online appendix for more detailed information). This data is supplemented by archival data and information from commercial financial databases such as Pitchbook.

Our results contribute to closing the existing research gaps in several ways. Firstly, by challenging the assumption that PRI preferences are "relatively fix[ed]" (Aksoy and Beaudry 2021), our analysis shows that PRIs' risk and reward assessments contribute to the heterogeneity of IP contracts along the two dimensions of IP ownership and payment terms. Consequently, a resource-based perspective on IP contract design should take into account the preferences of both research institutions and spin-offs. We find that PRI preferences are influenced to varying degrees by their resource endowments and IP strategies. Secondly, by examining the transfer of IP ownership, we explore an additional dimension of heterogeneity in IP contracts, where universities and non-university research institutions are shown to diverge. While university technology transfer managers generally report that they negotiate a wider range of contract patterns, the observed distribution across non-university research institutions is more homogenous. Thirdly, by providing insights into technology transfer practices in Germany, a country with a significant public research landscape, we con-

tribute to a geographically diversified understanding of IP contract patterns. Country-specific empirical data on IP contract heterogeneity is a starting point for further investigation of technology transfer practices in order to design more effective technology transfer strategies and implement policies that take into account the diversity of the research landscape.

The paper is structured as follows: Section 2 reviews prior work on IP contract design. Section 3 details the research design, data collection, and analysis. Section 4 presents the quantitative and qualitative findings from the survey and the interview study. Section 5 discusses the key results, and Section 6 concludes the study and suggests avenues for further research.

2 Theoretical background

2.1 Technology transfer through spin-off-creation

The commercialization of scientific results involves several pathways (Fini et al. 2018; Grimaldi et al. 2011). The formal knowledge transfer includes academia-industry cooperation, the licensing of IP to established companies, and spin-off creation (Abreu and Grinevich 2013). Multiple spin-off-definitions co-exist (Kenney and Patton 2011). For this study, spin-offs are defined as “new ventures that are dependent upon licensing or assignment of the institution’s intellectual property for initiation” (Lockett and Wright 2005, p.1044 f.). As PRIs aim to capture a share of the economic value generated from internally developed IP, they negotiate contracts with the technology transfer recipients (Coupet and Dickens 2024; Savva and Taneri 2015). These contracts provide the IP for subsequent commercialization through the spin-off and stipulate the spin-off’s obligations in return.

In the literature on licensing agreements, great attention is paid to payment terms. Licensing agreements often consist of different payment terms (Feldman et al. 2002; Jensen and Thursby 2001). On the one hand, cash compensation consists of fixed fees, royalties, and milestone payments. On the other hand, equity compensation generates income for the licensor through dividends or upon selling the equity stake. Equity stakes and royalty payment are contingent payments, i.e., their value results from the future performance of the spin-off (Savva and Taneri 2015). While early research focused on the distribution of fixed fees and royalty payments in licensing agreements with established companies (Savva and Taneri 2015), equity rather than royalties has increasingly been seen as a means of aligning the interests of research institutions and spin-offs, as well as increasing the revenue potential of PRIs (Feldman et al. 2002). Given the problems of adverse selection and moral hazard¹ associated with IP contracts, it was concluded that “[r]oyalties and equity cause distortions

¹ Adverse selection refers to the difficulties of an investor when selecting from a pool of firms in need for external finance because the investor “cannot distinguish a good firm from a bad one.” Consequently, the investor grants funding at a higher rate to compensate for the risk of failure if the funded firm turns out to be bad. Moral hazard refers to the difficulties of an investor after funding was granted to a firm: The firm’s management might use the funding granted to it for other purposes than originally specified or make other decisions that threaten the repayment of the investor. (Hyytinen and Väänänen 2006)

and either could be used as a screening device. As a result of the tension between the desire to use fixed fees to address the moral hazard problem and equity to address the adverse selection problem, the optimal contract includes all three terms" (Savva and Taneri 2015, p. 1338). However, prior literature lacks a similarly thorough analysis of payment terms for purchase agreements. In the following, the theoretical perspective of the resource-based view serves to examine the PRIs' risk and reward assessment regarding the terms of payment and the transfer of IP ownership to the spin-off.

2.2 The resource-based view on IP contract patterns

Applying the resource-based view of for-profit businesses to higher education, scholars argued that PRIs operate in a competitive environment, vying for research funding, highly qualified faculty and students, and positioning in annual rankings (Powers and McDougall 2005). A stream of literature on academic entrepreneurship has emerged that focuses on examining the resources and capabilities of PRIs (Gómez et al. 2008). Organizational capabilities, i.e., "performing a coordinated set of tasks, utilizing organizational resources", are understood "as an extension of the resource-based view, in which not only an organization's assets but also its capabilities lead to organizational performance" (Rasmussen and Borch 2010, p. 603). However, organizational capabilities and resources are more often associated with technology transfer and spin-off performance than with IP contract design. Powers and McDougall (2005) identify various resources that influence technology transfer performance. They conclude that the amount of research funding provided by industry partners, the quality of faculty as a source of expertise, the availability of venture capital in the PRIs' environment, and the experience of the technology transfer office (TTO) predict both the number of spin-offs created and the number of IPO licenses. In addition to experience, the size of investments in TTO staff also contributes to the increase in spin-off activity (O'Shea et al. 2005). These findings were confirmed and expanded by pointing to the positive influence of "soft" support measures and infrastructure (incubators, science parks) on spin-off performance (Gómez et al. 2008). Regarding the terms of payment, the share of equity payment schemes in IP contracts is positively related to the age of the TTO: the older the TTO, the more often the research institution becomes a shareholder of the spin-off in exchange for licensing the IP (Feldman et al. 2002) and the faster licensing contracts are executed (Markman et al. 2005a, b), and experienced managers are better able to negotiate and draft contracts (Aksoy and Beaudry 2021).

While there is yet little evidence that the resource base and organizational capabilities of research institutions are related to the IP contracts, the resource-based view has been used to relate the resources of licensees, e.g., spin-offs or established companies, to payment terms. Aksoy and Beaudry (2021) argue that the size and resources of the licensee influence the negotiated payment scheme. For spin-offs, they postulate that they "will be associated with equity-based payment schemes due to the differences in risk and reward these terms bring to the collaboration and the idiosyncratic characteristics of the licensee company" (Aksoy and Beaudry 2021, p. 2057). Their framework reflects that spin-offs and established companies license university IP to gain a competitive advantage. However, licensing also entails risks

such as financial obligations and knowledge spillovers. Aksoy and Beaudry (2021, p. 2057) differentiate that “a small company might value financial resources more [...] due to their scarcity, while larger companies might be more concerned by outgoing spillover that might erode their competitive advantage.” In line with prior research, they argue that a spin-off, where an equity stake is granted instead of cash compensation, is associated with reduced financial risk for the company: The spin-off “does not suffer financial consequences” as the research institution is compensated through dividends or the sale of its shares. Therefore, the research institution has a strong interest in the development of the spin-off, which means that “equity increases the interest of the licensor in the technology transfer success without increasing the cost for the [company]” (Aksoy and Beaudry 2021, p. 2056 f.). However, the PRI’s equity stake stems from the founding team’s shares in the spin-off, which may influence the founders’ financial incentives. If the founding team does not control a significant share of the spin-off, potential investors may be deterred from investing (Fini et al. 2017). Consequently, spin-offs eventually suffer “financial consequences” when they become less attractive to potential investors for negotiating a significant equity stake instead of cash compensation in exchange for accessing the IP.

While this accounts for the spin-offs’ perspective on the risk and reward assessments of IP contract patterns, it does not yet include the perspective of the owners of the IP, namely the PRI. While Aksoy and Beaudry (2021) acknowledge that universities vary in their objectives and that country- and industry-specific differences influence decision-making regarding technology transfer practices, they assume that universities’ preferences are “relatively fix”, i.e., that the observed heterogeneity of IP contracts is mainly “the manifestation of preferences of the licensee companies” (Aksoy and Beaudry 2021, p.2057). We challenge this assumption. Building on the work of Aksoy and Beaudry (2021, p. 2056 f.), we also consider the main risk of PRIs to be “the loss of the resources invested”, while the reward is understood as “the amount of financial income”. However, we also consider differences in the risk and reward assessment of research institutions and their influence on the preferences of PRIs in the design of IP contracts. We then derive propositions that guide the data collection and analysis to answer the research question: How do individual risk and reward assessments of public research institutions influence the design of IP contracts in the German biotechnology industry?

2.3 Risk and reward assessments of research institutions

We propose that PRI’s risk and reward assessments vary and thus influence their preferences for different IP contract patterns. In IP contract negotiations with spin-offs, varying PRI preferences contribute to the heterogeneity of IP contracts. Figure 1 displays a theoretical framework that incorporates prior literature on IP contract negotiations and illustrates the two negotiating partners and their associated risks and rewards.

While Aksoy and Beaudry (2021) examined the different preferences of licensees, such as spin-offs or established firms, our subsequent investigation focuses on the different preferences of PRIs. It begins with the development of three propositions (P1-P3 in Fig. 1): Firstly, it is argued that while spin-offs have been

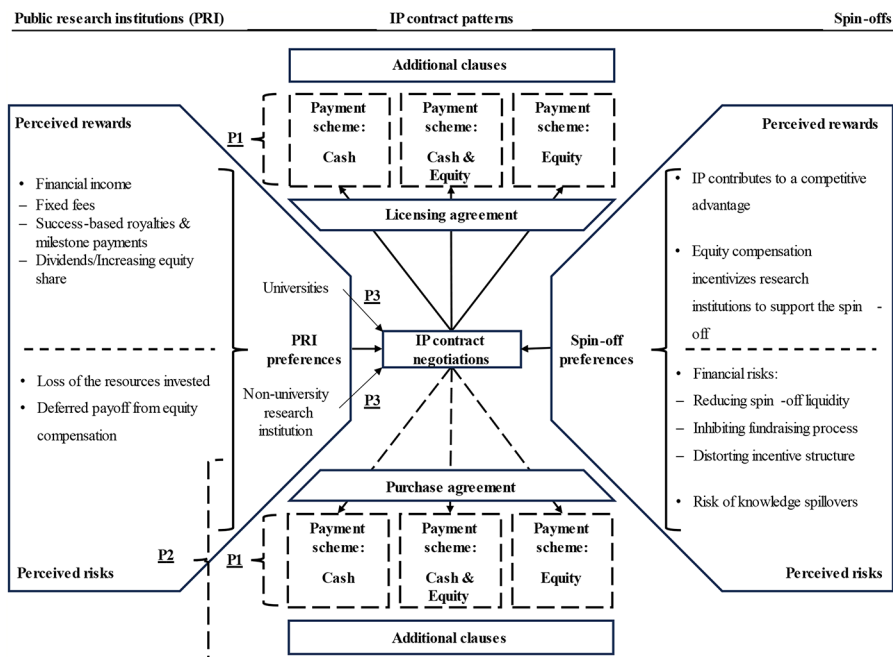


Fig. 1 Theoretical framework of the perceived risks and rewards in IP contract negotiations

reported to prefer equity compensation over cash compensation to preserve their financial resources, PRIs differ in their willingness to accept equity compensation as a payment scheme (see P1 in Fig. 1 for license and purchase agreements). The willingness of PRIs to accept equity compensation is influenced by several factors, including risk aversion, prior experience, budgetary scope, and decision-making processes. If the decision-making process for equity agreements requires approval from higher governing bodies of the PRI, the additional level of governance acts as a deterrent to equity compensation (Doran et al. 2024). Consequently, depending on the PRIs' governance structures, the propensity to negotiate equity agreements varies. Furthermore, combining an equity agreement with a licensing agreement increases the complexity of contract negotiations and transaction costs due to additional legal expenditures (Coupet and Dickens 2024). Although legal skills are emphasized for TTO personnel (Siegel 2011), transaction costs tend to decrease mainly as the TTO personnel gains experience (Shen et al. 2022). However, higher transaction costs associated with less experienced TTO personnel possibly discourages the acceptance of equity compensation, when, for example, external expertise is required to draft equity agreements. Moreover, equity payment schemes are regarded as high-risk options from the PRIs' perspective (Aksoy and Beaudry 2021). In contrast to a short-term cash reward, liquidating equity can take considerably longer, if it materializes at all, given the risk of spin-off failure (Kim and Daim 2014). Even though "equity held the promise of enabling the university to share in potentially larger revenues if a licensee flourished [...], these revenues were perceived to be highly uncertain"

(Feldman et al. 2002, p. 109). It is therefore anticipated that budgetary concerns will exert a further influence on the decision to accept equity compensation. Nevertheless, the rise in entrepreneurial PRIs that “invest intellectual and financial capital” (Etzkowitz 2004, p. 70) in exchange for an equity stake in the spin-off indicates that for these institutions, the rewards associated with equity compensation outweigh their perceived risks. Moreover, while royalty payments are more prevalent as contingent payments, equity compensation is highly remunerative if the spin-off is successful (Doran et al. 2024; Jensen and Thursby 2001) and offers the additional benefit that the PRI participates in the spin-offs’ success even if the transferred technology is replaced (Bray and Lee 2000). It can therefore be proposed (P1) that the varying assessments of PRIs with regard to equity compensation contribute to the heterogeneity of IP contracts concerning the terms of payment for technology transfer.

Secondly, it is argued that while prior literature emphasizes IP licensing (Doran et al. 2024; Shen et al. 2022), the alternative transfer of IP ownership from the PRI to the spin-off further contributes to IP contract heterogeneity (see P2 in Fig. 1). The spin-off’s technology and know-how constitute its foundational IP, comprising patents, trade secrets, and tacit information (Woolley 2017). Patents represent a vital resource, particularly for biotechnology spin-offs (Abreu and Grinevich 2013; Wright et al. 2006). In addition to the terms of payment, IP ownership constitutes a second dimension of IP contract heterogeneity (Kulicke 2023a; Wright et al. 2006). The varying interplay between the PRI, the spin-off, and prospective spin-off investors gives rise to heterogeneity. Prior to raising funds, spin-offs typically lack the financial resources to acquire IP ownership, unless the PRI makes concessions to the spin-off. One such concession might be the offering of license-like payment conditions. While exclusive licenses for the spin-off are the minimum requirement to attract investors in the biotechnology industry (Shen et al. 2022), some investors demand the transfer of patent ownership. In the event of a spin-off failure, investors may attempt to mitigate their losses by recovering and selling the IP (Wright et al. 2006). Similarly, PRIs tend to prefer retaining control over the IP, as this enables them to pursue further licensing opportunities in the event of spin-off failure. In the event that both the PRI and prospective investors demand IP ownership, the PRI is faced with the dilemma of maintaining control over the IP through licensing agreements or transferring ownership in order to secure funding for the spin-off. The assessment of this issue is likely to vary depending on the negotiating power of the PRI and the overall funding environment of the spin-off. Furthermore, if PRIs are constrained by limited financial resources, concerns about funding may impede their inclination to retain IP ownership, particularly given the financial burden associated with maintaining an extensive licensing portfolio, which may include covering the legal costs associated with patent infringements (Markman et al. 2005). Consequently, the second proposition (P2) posits that the varying considerations for IP ownership rights contribute to IP contract heterogeneity, encompassing licensing and purchase agreements.

Thirdly, it is proposed that patterns of PRI preferences can be distinguished between universities and non-university research institutions. Prior literature has tended to emphasize technology transfer from universities, while often overlooking non-university research institutions (Siegel et al. 2023; Woolley 2017). The role of

non-university research institutions in supporting spin-offs (Slavtchev and Göktepe-Hultén 2016), informal technology transfer (Grimpe and Fier 2010), and public research-industry relationships (Giannopoulou et al. 2019) is also examined. Nevertheless, the literature on spin-off creation has paid less attention to non-university research institutions. Prior research utilizing interview and/or survey data (Coupet and Dickens 2024; Jensen and Thursby 2001; Savva and Taneri 2015; Wright et al. 2006), as well as case studies (Clarysse and Moray, 2004), has concentrated on universities. However, it is anticipated that their technology transfer practices will diverge due to the existence of regulatory and organizational differences between universities and non-university research institutions. In Germany, the regulations pertaining to IP ownership at universities and non-university research institutions have developed separately. While the framework for institutional IP ownership was established in 2002 for universities, non-university research institutions had already been operating within this framework for several years (Kulicke 2023a). This resulted in the earlier development of processes for negotiating IP contracts in German non-university research institutions. Moreover, the regulatory frameworks governing the negotiation of equity agreements exhibit considerable variation. The Federal Ministry of Research and Education has introduced guidelines for equity agreements that federal non-university research institutions may enter into with IP-based spin-offs (BMBF 2012). The regulatory frameworks for universities differ depending on the Higher Education Laws that govern their activities in the respective states. There are 16 Higher Education Laws in total (Berghaeuser and Hoelscher 2020; Hemer et al. 2010; Kulicke 2023a). Furthermore, organizational structures differ. The Max Planck and Fraunhofer Society manage a substantial number of spin-offs, as they oversee the transfer activities of numerous research institutes (Fraunhofer Venture; Max Planck Innovation GmbH 2016; Slavtchev and Göktepe-Hultén 2016). In contrast, most universities oversee a considerably smaller number of spin-offs (Wright et al. 2008). In this respect, the relatively autonomous institutes of the Helmholtz Association (Siegel et al. 2023) bear closer resemblance to universities. In contrast to the more centralized approaches of the Max Planck and Fraunhofer societies, the research institutes of the Helmholtz Association are characterized by a greater degree of independence in terms of their technology transfer practices (Helmholtz Association of German Research Centres 2021). The third proposition (P3) suggests that the existence of different regulatory frameworks for universities and non-university research institutions gives rise to IP contract heterogeneity, with variations evident in the IP contracts negotiated with universities and non-university research institutions, respectively.

3 Research design

The confidential nature of IP contracts and the dearth of large-scale quantitative data call for an exploratory approach to gain insight into phenomenon of PRI preferences for IP contracts (Corbin and Strauss 2015). A two-step mixed-methods research design was employed, combining survey data for initial empirical data with subsequent expert interviews to obtain deeper insights. In this body of literature, analogous

methodologies have been employed for the triangulation of data (Munari et al. 2016; Wright et al. 2006) and for the exploration of supplementary questions (Hertzfeld et al. 2006; Jensen and Thursby 2001). The research setting is that of German biotechnology spin-offs because they meet several crucial criteria that are essential for our analysis and for addressing the identified research gaps. Firstly, the biotechnology industry provides an appropriate context for this study, as the commercialization of scientific results from PRIs is strongly driven by spin-offs in the life sciences (Bonardo et al. 2010; Gómez Uranga et al. 2007). By focusing on a single industry, we are able to avoid industry-specific deviations in contract designs, thus creating a homogeneous research setting that allows for the differentiation of PRI preferences. Secondly, Germany represents a dynamic research environment for the biotechnology industry (acatech 2016). However, the absence of empirical data on IP contract patterns in this context represents a notable gap (Kulicke 2023b). The distribution of public funding for scientific research and technology transfer activities is shared between university and non-university research institutions (Perkmann et al. 2021), thus enabling us to address the research gap on IP contract patterns from non-university research institutions (Siegel et al. 2023; Woolley 2017).

3.1 Survey data collection and analysis

The design of the self-administered web-based survey is informed by a synthesis of existing literature and insights gleaned from pre-study interviews with technology transfer experts. The survey is comprised primarily of closed-ended questions and is divided into three sections: (i) spin-off demographics, (ii) IP contract, and (iii) technology transfer process. The objective of the survey is to gain exploratory insights. A list of 218 German biotechnology ventures that originated in the peripheries of PRIs was compiled through internet research and the commercial database Pitchbook. The survey was distributed to participants via email or the networking platform LinkedIn. The invitation package included an information sheet outlining the details of the research project and a link to the survey on the Unipark EFS platform. A reminder was sent four weeks after the initial invitation. The data was collected during the months of June and July 2022. Of the 218 identified biotechnology ventures, 62 provided responses. Following the exclusion of 23 ventures lacking an IP contract, the remaining 39 respondents provided data on an IP contract with a licensing, purchase, and/or equity component. A comparison of the distribution of company characteristics in the survey sample and the identified population revealed no systematic deviations in terms of founding year, type of research institution in which the company originated, industry sectors, or location of the headquarters (see Table 2 in the online appendix). We therefore argue that the exploratory survey data provides an appropriate foundation for further analysis. The veracity of the data is further substantiated by a process of triangulation, whereby the results of the semi-structured expert interviews with technology transfer managers of German PRIs are integrated.

3.2 Qualitative data collection and analysis

The semi-structured expert interviews were conducted with practitioners from TTOs of various German PRIs. The survey results informed the formulation of the interview guidelines. Conversely, the expert interviews were employed to triangulate, complement, and expand the survey data from the spin-offs' perspective, integrating the perspectives of the technology transfer managers. In this way, we were able to investigate the impact of the PRIs' preferences on IP contract patterns. Expert interviews are a common method in empirical research (Meuser and Nagel 2009). An expert is defined as an individual who has acquired a specific area of knowledge either through formal education or through the performance of a particular role, such as that of a technology transfer manager (Misoch 2019). Purposive sampling was employed to identify TTO employees with extensive experience in PRIs with a notable history of technology transfer activity. Data was collected through interviews with technology transfer experts from universities and non-university research institutions, including the Fraunhofer Society (Gilain et al. 2022), the Helmholtz Association, and the Max Planck Society (Arnold et al. 2010).

The collection and analysis of qualitative data were conducted in an iterative manner between October and December 2022. The email invitations were accompanied by an information sheet that provided a description of the research project and outlined the interview guidelines (see online appendix). A total of 65 public research institutions were contacted for participation in the study. Of these, 33 experts from 27 research institutions were interviewed via Zoom. The data collection process was concluded once saturation was reached, i.e. when "there are no gaps in the explanations" (Corbin and Strauss 2015, p. 139 f.). In this study, saturation was reached when the interviews sufficiently accounted for all IP contract patterns observed in the spin-off survey and when explanations for different motivations and influencing factors began to recur. The total duration of the interviews was 1,176 min, with an average length of 43 min per interview (see Tables 1 and 3 in the online appendix for further information). The recordings were transcribed in their entirety and subsequently sent to the interviewees for confirmation. The coding was conducted using the software MAXQDA.

Following the assumption that the experts interviewed in our study are "knowledgeable agents", i.e. that they "know what they are trying to do and can explain their thoughts, intentions, and actions" (Gioia et al. 2013, p. 17), we initially developed first-order codes to capture the voice of the informants. The voices of the informants are represented through the use of "power quotes" in the following section, with the aim of illustrating the findings of our study (Pratt 2009, p. 860). Subsequently, these first-order codes are subsumed into second-order codes, thus combining the voice of the informant with the more abstract voice of the researchers (Gioia et al. 2013). We employ abductive reasoning (Mees-Buss et al. 2022) to develop an aggregate dimension based on the aforementioned second-order codes. Figure 2 depicts the resulting coding scheme, with illustrative quotations provided in Appendix 4.

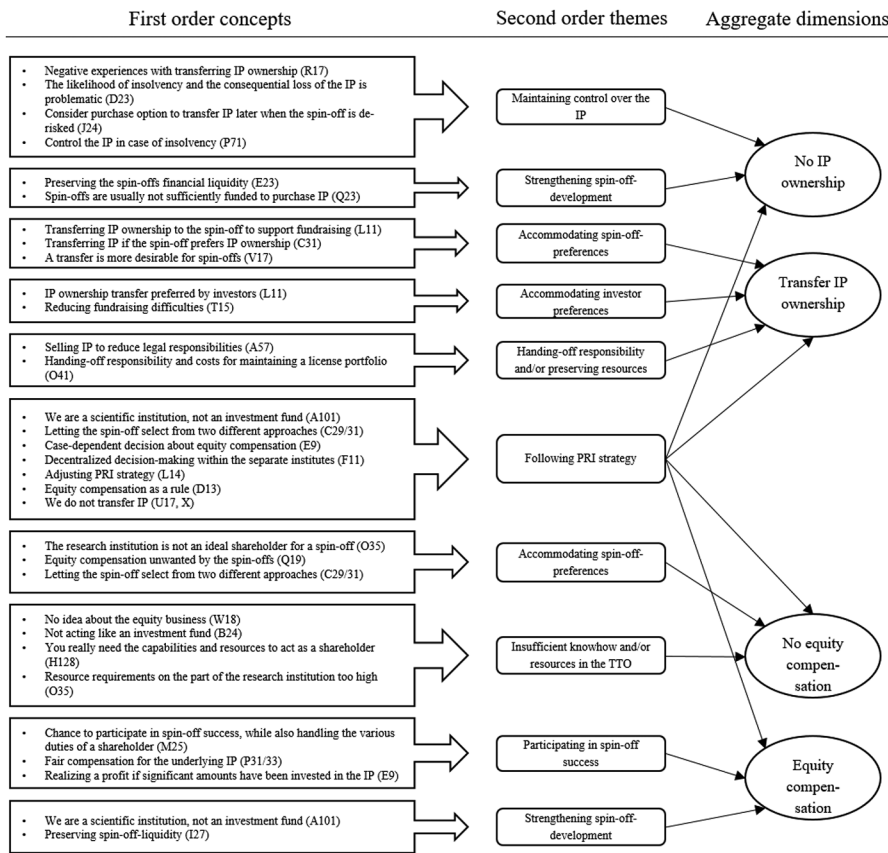


Fig. 2 Coding scheme

4 Results

4.1 Descriptive statistics of the survey and the interview study

In the sequential mixed-methods research design, the empirical data obtained from the survey on IP contract patterns informed the subsequent expert interview study conducted with technology transfer practitioners from German PRIs. Correspondingly, the descriptive statistics of the survey and the interview study are examined successively. The survey explored the distribution of IP contract patterns in the German biotechnology industry, with a focus on licensing, purchase, and equity agreements. The responses are further categorized according to the type of research institution with which the spin-offs negotiated their IP contract. As illustrated in Fig. 3, the majority of spin-offs in our sample originated in universities (black), while approximately one-third negotiated with non-university research institutions (white). The remaining spin-offs have two or more parent institutions, as indicated by the dotted line. The majority of IP contracts are single licensing and purchase agreements,

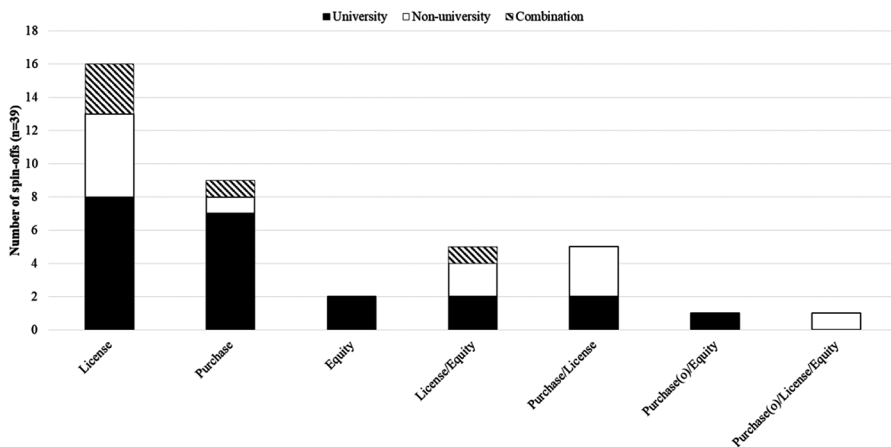


Fig. 3 Distribution of IP contract patterns in the survey data

followed by combinations of licensing/equity agreements and purchase/equity agreements, respectively.

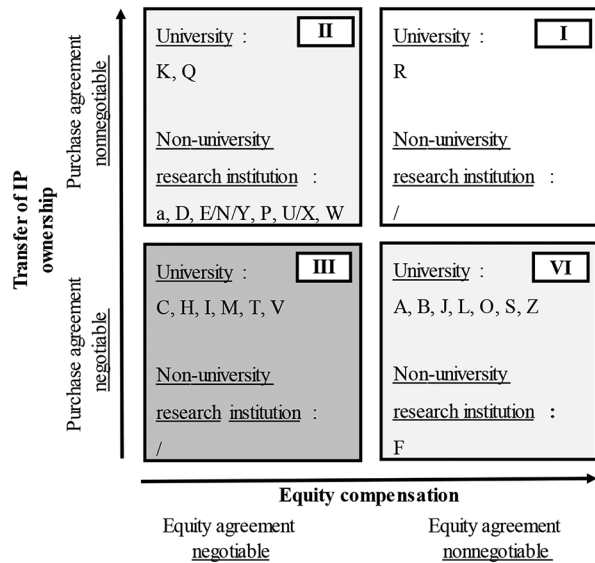
The survey data reveals a diversity of IP contract patterns among contracts negotiated between spin-offs and universities, as well as between spin-offs and non-university research institutions. While this diversity was overall confirmed for IP contracts negotiated with universities in subsequent expert interviews, the interview data collectively indicated a stronger emphasis on the combination of licensing and equity agreements for IP contracts negotiated between spin-offs and non-university research institutions. Two principal conclusions are drawn from the survey data. Firstly, while the majority of spin-offs license their IP, a number of spin-offs, primarily those originating from universities, opt to retain IP ownership. Secondly, it was reported that approximately a quarter of the participants in the survey had negotiated equity compensation. The findings of Aksoy and Beaudry (2021) are at odds with those of the present study, as only a minority of the surveyed spin-offs reported cash-preserving equity compensation. The survey results were triangulated with the input of technology transfer managers in expert interviews. Furthermore, we corroborated the statements made in the interviews with the published IP strategies² in order to examine how the individual risk and reward assessments of PRIs influence the design of IP contracts.

The distribution of PRI preferences for IP contract patterns is illustrated in Fig. 4, based on the results of the interview study (see Table 4 in the online appendix for exemplary quotes) and secondary data analysis. The preferences are categorized along two dimensions³: firstly, whether the PRIs permit the transfer of IP owner-

² Transparency regarding IP strategies varies at German universities. Often the strategies are not published in full or are not available as a collection of regulations on a website (Kulicke 2023a).

³ As reported above, licensing agreements make up most IP contracts in line with prior literature and are offered by almost all technology transfer offices. Therefore, this analysis focuses on purchase and equity agreements. Purchase options are not considered as a purchase agreement, because we explore the immediate transfer of IP ownership.

Fig. 4 Distribution of the research institutions' reported preferences on IP contract patterns



ship to the spin-off (represented on the y-axis); secondly, whether the PRIs accept spin-off equity as a form of payment (represented on the x-axis). In the course of the interview study, the participants from universities predominantly indicated that the transfer of IP ownership can be negotiated (see quadrants III and IV), even though the conditions for the transfer of IP ownership vary. Nevertheless, it is noteworthy that a third of the participants in the study reported that they do not engage in negotiations regarding equity agreements (see quadrants I and VI). Compared to universities, homogeneity across IP contracts is more widespread in the statements of participants from non-university research institutions, who almost exclusively report negotiating licensing agreements with or without an equity agreement.

Nevertheless, institutions situated within the same quadrant may still exhibit discrepancies in terms of the specific IP contract patterns that they negotiate. While University C (quadrant III) reportedly offers either a licensing agreement with a purchase option or a purchase agreement combined with an equity agreement, University H reportedly offers all combinations to the spin-offs. In the 2nd quadrant, licensing agreements and equity agreements are typically, though not exclusively, combined. It is also important to note that these preferences are not static. As several interviewees indicated, modifications to the PRIs' IP strategies are either planned or have recently occurred, which highlights the dynamic nature of these preferences.

The preferences of the PRIs for IP contract patterns are associated with their perceptions of risks and rewards. In accordance with the observations of Aksoy and Beaudry (2021), it can be seen that the interviewees' assessment of rewards is frequently linked to their involvement in the success of the spin-off. The potential loss of the IP in the case of spin-off insolvency is a significant risk factor. Nevertheless, the aforementioned considerations are interpreted and weighted differently by the interviewees, which consequently gives rise to a divergence in their preferences pertaining to the transfer of IP ownership and equity agreements.

4.2 Transfer of IP ownership

In opposition to the transfer of IP ownership, and in accordance with prior literature, the negotiation of licensing agreements is driven by considerations for maintaining control over the IP. The majority of interviewees recognize the benefits of retaining control at the outset of spin-off development to preserve the commercialization potential of the IP in the event of spin-off insolvency. Conversely, the immediate transfer of IP ownership to the spin-off by negotiating a purchase agreement is reportedly associated with different preferences. These preferences (see second-order themes in Fig. 2) can be broadly categorized as follows: (i) to transfer responsibility and reduce expenses associated with the management of a licensing portfolio; (ii) to accommodate the preferences of the spin-off; (iii) to accommodate the preferences of investors; or (iv) to maintain control over the IP.

Firstly, a minority of interviewees report that transferring IP ownership to the spin-off entails certain rewards (1): While licensing agreements result in liabilities and costs for the TTO, "you can draw up a purchase agreement with license-like conditions, and then you have certain burdens gone" such as "liability for the care of the portfolio [and] the ongoing personnel expenses for the care of the portfolio." This indicates the perceived benefits of handing off responsibility for the care of the portfolio and preserving resources, particularly for smaller institutions. Similar to the influence of the PRIs' resource endowments on the decision to offer equity compensation (Feldman et al. 2002), the resource endowment also seems to influence the decision to transfer IP ownership.

Secondly, the accommodation of spin-off or investor preferences is observed, primarily, though not exclusively, in interviews with university personnel (ii, iii). A number of institutions endeavor to provide a diverse range of contract options to "offer as much as possible and let the founders decide what best suits their plans", with the underlying assumption being that this will increase the likelihood of spin-off success through a tailored IP contract. In many instances, the preferences of spin-offs and investors are aligned. This is illustrated by the following statement from an interviewee: "We offer everything, and the founding team ultimately makes the decision. [...] In my opinion, that has to do with whether the investor is already there or not. [The investor] wants to buy, and if the spin-off stands alone, they can't buy it." Nevertheless, the perception of investor demands appears to be contingent upon the TTO's assessment of investors' claims to IP ownership. A majority of interviewees acknowledge investor interest in transferring IP ownership to the spin-off. However, two distinct approaches to addressing this interest have been observed. One group of interviewees emphasizes the necessity of transferring IP ownership, citing the risk of losing investor interest as the rationale: "There is a transfer of IP for the simple reason that any investor who comes will force the team to get the IP. And if they don't get the IP, they don't invest." Approximately one-third of the interviewees indicated that they perceive such a necessity.

Nevertheless, interviewees more frequently distinguish between investor preferences. About half of the interviewees report that transferring IP ownership is usually not considered to be a precondition for successful spin-off fundraising and they prefer to maintain control over the IP (iv). These interviewees, more often based

in non-university research institutions, are aware of and understand the abovementioned claims of the investors. However, rather than transferring the IP, they negotiate licensing agreements (with or without an equity agreement). Several interviewees report that “it depends on how you design the license. A license can, of course, be critical and inhibitory [...]. Still, if you take these things into account, if you create an ownership-like situation [...] through licensing, then I think it’s a myth that investors would always demand [IP ownership].” If such an “ownership-like situation” can be achieved through a licensing agreement, the alternative, i.e. the transfer of IP ownership to the spin-off, “is a very risky business and this IP can be lost quickly.” Nevertheless, the option of purchasing the IP is usually considered, which would enable its transfer to the spin-off after a certain period, when the risk of losing the IP in the event of the spin-off’s bankruptcy is perceived to be comparatively low.

The aforementioned statements suggest two implications for the perceived risk of losing investor interest: On one hand, the transfer of IP ownership rights to the spin-off results either from the institutions’ strategy and the decision of the spin-offs to acquire the IP ownership rights or from the persistence of external stakeholders, e.g. early-stage investors, not to accept a licensing agreement. On the other hand, the PRIs vary in their risk perception of losing investor interest by pursuing licensing agreements rather than transferring IP ownership to the spin-off.

4.3 Equity compensation

Given the paucity of data on equity compensation in the survey, we here observe the largest discrepancy between the survey and interview data. The interview study demonstrates that there are variations in the acceptance of equity compensation for licensing or transferring IP ownership among PRIs. The divergence in preferences can be attributed to three key factors: (i) differing IP strategies and considerations for participating in spin-off success, (ii) variations in PRI resource endowments, and (iii) differing perceptions of the role of strengthening spin-off development and accommodating stakeholder preferences (see second-order themes in Fig. 2). In only one interview was the legal framework of the universities identified as a potential impediment to the negotiation of equity agreements.

In interviews, individuals from non-university research institutions have almost universally indicated that they have negotiated equity shares as part of their compensation for licensing their IP. While a small number of documents are not publicly accessible, this is reflected in the strategies of the respective institutions (Deutsches Krebsforschungszentrum 2016; Fraunhofer Venture; Max Planck Innovation GmbH), thereby confirming prior findings (Kulicke 2023a). It is highlighted that equity compensation allows the PRI to participate in the success of the spin-off while maintaining the spin-off’s liquidity (i, iii). It has been reported, however, that this does not necessarily preclude backloaded cash compensation as part of the complementary licensing agreement.

The general overview presented by the university personnel is considerably more heterogeneous, likewise corroborating prior research (Kulicke 2023a). About half of the university interviewees report the acceptance of equity shares similar to their non-university counterparts. The remaining half, however, reports that equity com-

pensation is not considered because it is not the institutions' objective to become a shareholder (i), or because of the lack of know-how and resources required to fulfill the respective rights and duties (ii): "as a shareholder you have responsibility, and that also requires personnel resources and other expenses on the part of the university, which are not really profitable for us at the beginning." This suggests an unfavorable perception of the risks and rewards associated with equity compensation because the perceived expenses seemingly outweigh the potential gains. Additionally, some interviewees account for the preferences of other stakeholders (iii). One interviewee reports that equity agreements were simply not sought after in recent years and that cash compensation enabled a more accessible settlement. This indicates that usually cash-starved spin-offs do not necessarily prefer equity over cash compensation for technology transfer.

5 Discussion

The resource-based perspective of Aksoy and Beaudry (2021, p. 2056 ff.) identifies the primary risk faced by research institutions as "the loss of the resources invested" and the primary reward as "the amount of financial income". While the observed divergences in PRI preferences can mainly be associated with these two primary risks and rewards, deviations nevertheless contribute to IP contract heterogeneity because PRIs weigh these risks and rewards differently. By dispensing with the assumption that PRIs exhibit homogeneous preferences, we gain a more comprehensive understanding of IP contract heterogeneity. Despite the prevalence of licensing agreements, purchase agreements are more pervasive than prior literature suggests. Furthermore, the interview data indicates that the distribution of equity compensation is underrepresented in the exploratory survey. While minor discrepancies between contract patterns negotiated with university and non-university institutions were identified in the survey, the interview study revealed more pronounced differences. We examined IP contract heterogeneity in the context of three propositions: (P1) equity compensation, (P2) the transfer of IP ownership, and (P3) the deviations of universities and non-university research institutions. Figure 5 demonstrates how PRI preferences impact the selection of IP contract patterns and acknowledges that IP contract negotiations are similarly influenced by the preferences of the spin-offs (Aksoy and Beaudry 2021). In contrast to the uniform profile of PRI preferences displayed in Fig. 1. Figure 5 presents a more differentiated perspective derived from our findings.

Four profiles of PRI preferences were identified along the two dimensions of IP contract heterogeneity explored in this study (drawn from Fig. 4). The x-axis depicts the heterogeneity of remuneration for technology transfer, encompassing the combination of equity and cash or solely cash compensation. The y-axis illustrates heterogeneity regarding the transfer of IP ownership, with the options of maintaining or transferring IP ownership at the time of the conclusion of the contract. Consequently, the first quadrant (I) depicts the profile of PRIs that accept solely cash compensation and prefer to retain IP ownership. In the context of IP contract negotiations, this manifests in the pursuit of licensing agreements with cash compensation. In a complementary manner, the second quadrant (II) illustrates the profile of PRIs that

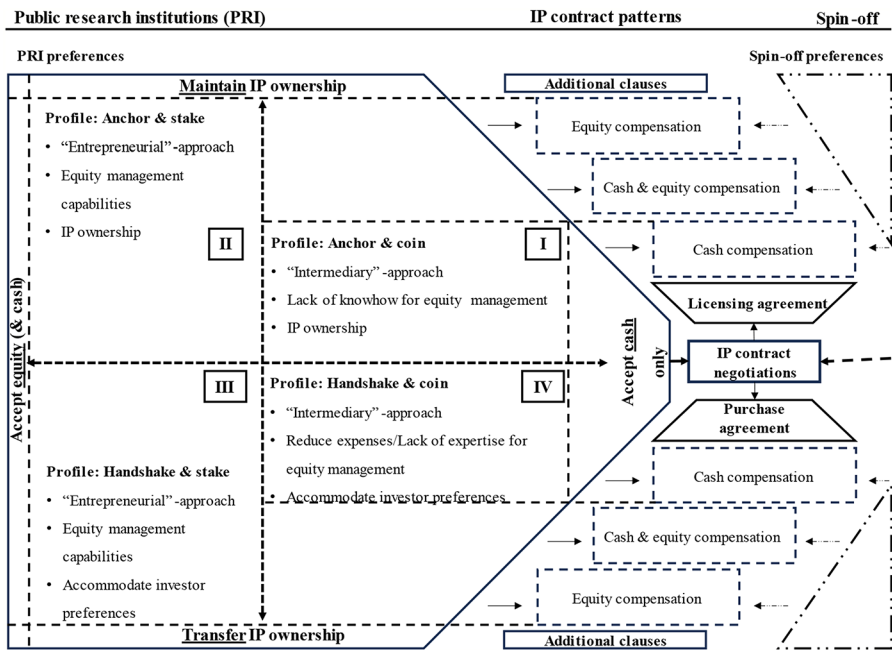


Fig. 5 PRI preferences and IP contract patterns

accept equity and/or cash compensation while also preferring to maintain IP ownership. This manifests in the pursuit of licensing agreements with equity compensation, either with or without a cash component. In contrast, the third and fourth quadrants illustrate the profiles of PRIs that prefer the transfer of IP ownership to the spin-off via purchasing agreements. The four profiles were labelled as combinations of the following: “Anchor” (the PRI holds onto the IP through licensing) and “Handshake” (the PRI transfers IP ownership to the spin-off); and “Coin” (the PRI prefers cash compensation) and “Stake” (the PRI prefers equity compensation with or without a cash component). The dotted lines separating the profiles of PRIs indicate that these classifications are not rigid and that deviations from the preferred approaches may occur in negotiations if necessary or if changes to the IP strategies occur.

5.1 Risk and reward assessment of equity compensation

The first proposition (coin- vs. stake-profile) is substantiated by the empirical data. There is considerable divergence among research institutions in their risk-reward assessment of equity compensation. Although equity agreements represent only a relatively minor proportion of the data set derived from the spin-off survey, the interview data suggests a more pronounced diffusion. On the one hand, equity compensation is well established with spin-offs from non-university research institutions and several more experienced universities. Prior literature associates a PRI’s investment of “intellectual and financial capital in exchange for equity” with an entrepreneurial university (Etzkowitz 2004, p. 70). However, this term requires expansion to encom-

pass “entrepreneurial public research institution” in order to accommodate the IP strategies of participating non-university research institutions, which frequently mandate equity agreements. In particular, the strategies of the Max Planck Society (Max-Planck-Innovation GmbH) and the Fraunhofer-Society (Fraunhofer Venture) appear to reflect an entrepreneurial approach. The interviewees from these institutions associate equity agreements with the opportunity to participate in the success of the spin-off and to preserve the liquidity of the spin-off. This aligns with the preferences of spin-off licensees as reported by Aksoy and Beaudry (2021), although it should be noted that the equity agreements of the Fraunhofer and Max Planck Society do not necessarily exclude the possibility of simultaneous cash compensation. Together with a several universities, the majority of these institutions are distinguished by a relatively high number of spin-offs. This can be attributed to either a high level of entrepreneurial activity within the respective university or to organizational factors that combine the transfer activities of multiple institutes within an overarching organizational unit (Fraunhofer Venture; Max Planck Innovation GmbH 2016; Slavtchev and Göktepe-Hultén 2016). This differentiates these institutions from other organizations, whose study participants report a more risk-averse approach to equity compensation.

A number of study participants, predominantly from universities, have indicated that they are reluctant to accept equity compensation on the grounds that it is not aligned with the institutions’ core objectives, which do not include becoming a shareholder. In lieu of pursuing an entrepreneurial stance, they act as intermediaries for technology transfer (Aksoy and Beaudry 2021; Howells 2006). In line with prior literature on minimizing financial and legal risks, equity compensation is not considered (Markman et al. 2005). This risk assessment is associated with a lack of expertise and resources required to fulfil the obligations of a shareholder. One interviewee posited that “especially smaller universities simply don’t have a number of cases for which it would be worthwhile to develop this competence.” Therefore, the lack of resources and organizational capabilities appears to outweigh the assessment of rewards associated with participating in the success of the spin-off while maintaining its liquidity. For a number of universities, the reward assessment is diminished by the costs and efforts associated with the rights and duties of shareholders. This is particularly the case when there is a relatively small number of expected spin-offs, which makes the investment disproportionate. Consequently, while a number of universities and non-university research institutions have been observed to invest intellectual capital in exchange for an equity share of the spin-off, thereby pursuing an entrepreneurial approach, others have been seen to adopt an intermediary stance (Aksoy and Beaudry 2021; Howells 2006). These assessments give rise to IP contract heterogeneity in relation to equity agreements, thereby substantiating Proposition 1.

Despite Aksoy and Beaudry (2021) identifying equity agreements as the preferred option for spin-offs, the individual preferences of research institutions can prevent the negotiation of such an agreement, necessitating the provision of cash compensation for technology transfer instead. Nevertheless, the distinction between an entrepreneurial approach with equity compensation as opposed to exclusive cash compensation is predominantly observed among university personnel. Accordingly, the risk and reward profile for equity compensation as outlined by Aksoy and Beaudry (2021) requires adjustment. The risk and reward assessment of accepting equity compensa-

tion varies among PRIs, which in turn influences IP contract negotiations and the propensity of spin-offs to negotiate equity compensation in order to conserve their financial resources. It is therefore necessary to adopt a resource-based perspective on the design of IP contracts which takes into account the preferences of both spin-offs and PRIs.

5.2 Risk and reward assessment of the IP ownership transfer

The second proposition (anchor- vs. handshake-profile) is confirmed by our findings, which reveal that there is a discrepancy between the risk and reward assessments of IP ownership control among the examined PRIs. The data obtained from the interviews largely corroborates the findings of the spin-off survey with regard to the distribution of purchase agreements. Patents represent a valuable resource, which is why the negotiation of IP ownership is a topic of considerable debate. The majority of interviewees acknowledge that investors are inclined to see the transfer of IP ownership to the spin-off and confirm the preference of PRIs to likewise maintain control over the IP by licensing it out (Wright et al. 2006). The observed heterogeneity in IP contracts regarding licensing and purchase agreements can be attributed to the disparate approaches employed to reconcile these competing interests. On the one hand, there is a transfer of IP ownership, which typically follows two lines of reasoning: The IP contract is either adapted to suit the requirements of the founding team and to accommodate the interests of potential investors or, in a minority of cases, purchase agreements are pursued with the objective of transferring responsibility and conserving PRI resources, rather than maintaining license portfolios. This indicates a discrepancy between the resource-intensive transfer activities and the resource constraints typically encountered in smaller institutions (Rasmussen and Wright 2015). Conversely, the majority of respondents from non-university research institutions and several universities indicated a preference for maintaining control through licensing IP.

In addition to differing IP strategies to accommodate spin-off preferences, there is also variation in the enforcement of licensing agreements, which is driven by different perceptions of investor interests and the risk assessment of insufficient spin-off fundraising. In their responses to the interview questions, several of the interviewees highlighted the importance of the conduct of negotiations in this context. They suggested that making a case for licensing by stressing the concept of “ownership-like situations” could be a key factor in determining the outcome of such negotiations. However, one interviewee proffers an additional explanation that may invalidate this line of reasoning. According to the interviewee’s experience, transfer of ownership is irrelevant as long as the investors “know it’s handled professionally”. Conversely, the pursuit of ownership is undertaken when “the other side is simply not very professional.” Further data is required from the perspective of investors in order to validate this statement. This would, however, suggest that potential investors may modify their strategy for acquiring IP ownership in accordance with their assessment of the TTO’s professionalism. If the TTO’s professionalism is perceived to be comparatively low by the investor, the discrepancy in expectations reported by Wright et al. (2006, p. 491) may be more pronounced, i.e., the investors would feel more uncomfortable

about investing when the IP is licensed rather than assigned to the spin-off. Should investors adopt a more assertive stance when they perceive their negotiating counterparts at the PRI to be less experienced, this may, in turn, influence the TTOs risk assessment. An increase in the aggressiveness of the investors' approach may result in a greater inclination to transfer IP ownership in order to facilitate funding for spin-offs. However, other factors are expected to further influence the negotiations, such as the diverse types of investors and their individual personalities (Macho-Stadler and Pérez-Castrillo 2010). Wright et al. (2006, p. 495) caution that the consequences of the discrepancy regarding IP ownership "have not been fully recognized, which has major implications for external equity-funded spin-[offs]." It can be seen that the implications for spin-offs are evident at the level of the IP contract design, in that a share of the negotiations results in the transfer of IP ownership. However, as these findings overlap with the tendency of some institutions to offer purchase agreements irrespective of investor pressure, it is challenging to ascertain the significance of institutions' perceived proficiency. A compromise between transferring IP ownership at the time of spin-off foundation and licensing agreements are purchase options where the transfer of IP ownership occurs after a designated period or upon the attainment of a specified milestone by the spin-off. It has been reported that these options are more prevalent than the survey data would suggest.

In general, when considering the transfer of IP ownership, it can be observed that the perceived risk of losing investor interest and thereby inhibiting spin-off development is more distinct among university personnel in the interview study. Nevertheless, as these tendencies coincide with IP strategies designed to accommodate spin-off and investor preferences for IP contract design, further research is necessary to examine the influence of risk aversion on the transfer of IP ownership. The impact of risk aversion on the formulation of spin-off contracts remains an area of ongoing investigation (Macho-Stadler and Pérez-Castrillo 2010).

5.3 Contract patterns of universities and non-university research institutions

While respondents from non-university research institutions almost unanimously report negotiating licensing agreements, often in combination with equity agreements, respondents from universities indicate more heterogeneous IP contract patterns. As a result, the third proposition is only partially confirmed. While non-university research institutions differ from universities in that they reportedly enforce their preference for maintaining IP control through licensing agreements more thoroughly (anchor over handshake in Fig. 5), they also follow an entrepreneurial approach similar to several universities by emphasizing equity compensation (stake over coin in Fig. 5). It can thus be proposed that the concept of "entrepreneurial universities" (Etzkowitz 2004) should be extended towards "entrepreneurial research institutions" to include non-university research institutions that accept an equity share in exchange for providing the IP. We observe, however, deviations in negotiating the transfer of IP ownership. Some entrepreneurial universities enable an immediate transfer of IP ownership to the spin-off if conditions are fulfilled that reduce the risk of spin-off failure and the subsequent loss of sold IP. Further, while some technology transfer managers of universities point out that failure to accommodate investor preferences concerning IP

ownership increases the risk of insufficient spin-off funding, most interviewees at non-university research institutions perceive this risk to be negligible.

The results highlight the necessity to differentiate technology transfer practices of universities and non-university research institutions to contribute to a more detailed understanding of the commercialization of scientific research results (Siegel et al. 2023). In the German research context, non-university research institutions demonstrate a greater degree of homogeneity in their preferences regarding IP contract designs, whereas those from universities report a more heterogeneous range of preferences. Further research is required to establish whether these country-specific findings can be generalized.

5.4 Limitations and practical implications

It is important to recognize the limitations associated with self-administered surveys. As with the findings of Aksoy and Beaudry (2021), which are based on the AUTM surveys, our own results are open to the influence of self-reporting biases. However, in contrast to surveys on sensitive subjects (Krumpal 2013), it can be reasonably assumed that the propensity of misreporting due to social desirability bias is relatively low. Similarly, despite the potential for recall periods of up to a dozen years, the requested information is explicitly outlined in the IP contract. The same is true of the selective recall bias. Nevertheless, in order to further reduce the probability of erroneous responses in the event of nescience, we provided the option of selecting “Do not know/Does not apply” as a potential answer. Although efforts were made to mitigate the impact of social desirability bias in the interview study by triangulating qualitative data with secondary sources, such as IP strategies, it is acknowledged that there may be instances where deviations from these strategies occur in IP contract negotiations.

Furthermore, survivorship bias represents a significant challenge to the explanatory power of survey-based analysis (Colombo and Piva 2012). It is notable that all the spin-offs in our sample are still active, despite the fact that founders and managers of insolvent biotechnology spin-offs were invited to participate in the survey. Consequently, the inferences derived from the survey data are susceptible to survivorship bias due to the absence of data on companies that have ceased operations. In order to estimate the proportion of inactive biotechnology spin-offs that can be expected, we refer to the findings of previous studies: A study of companies established to commercialize a life science technology developed at the top 50 patent-producing US universities between 1980 and 2013 revealed that 21.5% of companies failed⁴ (Godfrey et al. 2020). Given the definition and industry focus, it seems reasonable to suggest that this finding can be compared to the situation in Germany with regard to biotechnology spin-offs. As indicated in the ORBIS database, 24 of the 218 approached spin-offs were inactive at the commencement of the survey. In consequence, the proportion of inactive companies within the identified population of

⁴ Failure is considered „[e]vidence of activity, three or more employees at one time, and evidence of demise, either hard (bankruptcy or dissolution of corporate entity) or soft (no website, no press clippings or no current employees on LinkedIn or other sources)” (Godfrey et al. 2020, p. 134).

potential biotechnology spin-offs is 11%, which is approximately half the aforementioned estimate (see Table 2 in the online appendix). The survivorship bias implies that the explanatory power of the survey data is limited. Taking these drawbacks into account, we discussed the distribution of IP contract patterns in the semi-structured expert interviews with technology transfer managers who did not indicate strong deviations of the survey data from their experience. Following this triangulation, we conclude that the relatively high share of purchase agreements – given that they are rarely addressed in the literature on IP contracts–, as well as the relatively low share of equity agreements – given that prior literature identified increases in equity agreements – are somewhat driven by the high share of university-based spin-offs as opposed to non-university institutions. However, we are confident that the data is a fair representation of the phenomena: The shares of university-based spin-offs in the survey sample and the identified population (56,4% and 58,7%), and the respective shares of non-university-based spin-offs (30,8% and 29,4%) are relatively well-matched.⁵ Overall, the generalizability of our findings is limited to German spin-offs in other industries. As our exploration focuses on spin-offs and experts from German PRIs, varying national regulations inhibit generalization across countries. Transferring our findings to spin-offs from other industries can be expected to be more applicable to ventures that share characteristics of life science spin-offs, such as the importance of patents for spin-off development.

The findings of this study have the potential to inform the practices of technology transfer managers, founders of spin-off companies, and policymakers. Firstly, our exploratory study addresses the paucity of empirical data on IP contract patterns in Germany, thereby providing a foundation for a more data-driven discussion on IP strategies across all stakeholders. A more nuanced understanding of the factors that contribute to IP contract heterogeneity would facilitate a more constructive debate on the benefits of standardization in IP contracts, thereby increasing the likelihood of developing a joint solution. Secondly, our theoretical framework provides insight into the perspective of the PRI in IP contract negotiations, thereby enabling spin-off founding teams to adapt their conduct of negotiations. To illustrate, a more informed understanding of the PRI's preferences for maintaining IP ownership allows for a more targeted approach to IP contract negotiations when the spin-off and prospective investors demand the transfer of ownership. Similarly, if equity agreements are typically considered non-negotiable, alternative approaches, such as virtual shares, can be addressed in contract negotiations by emphasizing reductions in transaction costs and risks while acknowledging the PRI's preferences for risk aversion. Thirdly, our findings provide empirical data that can be used as a basis for further examination of technology transfer practices. This would enable policymakers to consider the risk and reward assessment of public research institutions and to develop more tailored technology transfer strategies.

⁵ The remaining 12,8% (sample) and 11,9% (population) refer to spin-offs originating from two or more research institutions.

6 Conclusion

The creation of spin-offs is becoming an increasingly important aspect of capitalizing on public investments in universities and non-university research institutions. These nascent, innovative enterprises are pivotal drivers of job creation, innovation, and productivity growth (Block et al. 2018). Nevertheless, there is frequently a discrepancy between the pace of empirical evidence on spin-off creation and development and the advancement of policy initiatives. Although the IP contract is a necessity for spin-off creation and exerts an influence on early-stage development, empirical data on IP contract heterogeneity remains scarce. In order to address this gap in the literature, we complement the resource-based perspective on the influence of licensees on IP contract patterns, as put forth by Aksoy and Beaudry (2021), with an examination of the influence of research institutions on equity, licensing, and purchase agreements in the German biotechnology industry. The data obtained from the survey and interviews indicate that the resource endowments and IP strategies of the research institution have a significant impact on their risk and reward assessments, which in turn result in IP contract heterogeneity with regard to the terms of payment and IP ownership. Our findings indicate that non-university research institutions display similarities to universities with regard to their entrepreneurial approach, frequently negotiating equity compensation – typically combined with cash compensation – in exchange for technology transfer. Nevertheless, non-university research institutions in our study exhibit a more pronounced inclination for retaining control over IP through licensing agreements, thereby distinguishing themselves from universities in this particular aspect.

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Data availability The full interview transcripts that supported the development of the Coding scheme in Fig. 2 are not publicly available to guarantee interviewee anonymity. However, exemplary quotes that informed the development of Fig. 4 are made available in Table 4 (online appendix) and were translated into English from the original German interview transcripts. Further information on the interview guidelines and on the composition of the interview study participants is made available in the online appendix. The descriptive statistics on IP contract patterns supporting Fig. 3 are not publicly available in order to guarantee survey participant anonymity. Supplementary data on the survey data is also made available in the online appendix. All Figures were developed with either PowerPoint or Excel.

Declarations

Ethics approval This work was supported by the German Federal Ministry of Education and Research. The authors have no relevant financial or non-financial interests to disclose. All authors contributed to the study conception and design. Material preparation and data collection were performed by [Author 1], and analysis by both authors. The first draft of the manuscript was written by [Author 1] and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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References

- Abreu M, Grinevich V (2013) The nature of academic entrepreneurship in the UK: widening the focus on entrepreneurial activities. *Res Policy* 42:408–422. <https://doi.org/10.1016/j.respol.2012.10.005>
- acatech (Ed.). (2016) Innovation potential of Biotechnology: Acatech IMPULS. Executive Summary. Munich <https://en.acatech.de/publication/innovation-potential-of-biotechnology/>
- Aksoy A, Beaudry C (2021) How are companies paying for university research licenses? Empirical evidence from university-firm technology transfer. *J Technol Transf* 2051–2121. <https://doi.org/10.1007/s10961-020-09838-x>
- Ambos TC, Mäkelä K, Birkinshaw J, D'Este P (2008) When does University Research get commercialized? Creating ambidexterity in Research Institutions. *J Manag Stud* 45:1424–1447. <https://doi.org/10.1111/j.1467-6486.2008.00804.x>
- Arnold E, Clark J, Jávorka Z (2010) Impacts of European RTOs: a study of Social and Economic Impacts of Research and Technology Organisations. A report to EARTO. Technopolis Group Ltd
- Berghaeuser H, Hoelscher M (2020) Reinventing the third mission of higher education in Germany: political frameworks and universities' reactions. *Tert Educ Manag* 26:57–76. <https://doi.org/10.1007/s11233-019-09030-3>
- Block JH, Colombo MG, Cumming DJ, Vismara S (2018) New players in entrepreneurial finance and why they are there. *Small Bus Econ* 50:239–250. <https://doi.org/10.1007/s11187-016-9826-6>
- Bonardo D, Paleari S, Vismara S (2010) The M&A dynamics of European science-based entrepreneurial firms. *J Technol Transf* 35:141–180. <https://doi.org/10.1007/s10961-009-9109-3>
- Bray MJ, Lee JN (2000) University revenues from technology transfer. *J Bus Ventur* 15:385–392. [https://doi.org/10.1016/S0883-9026\(98\)00034-2](https://doi.org/10.1016/S0883-9026(98)00034-2)
- Bundesministerium für Bildung und Forschung (2012) Leitlinie zur Beteiligung von Forschungseinrichtungen an Ausgründungen zum Zwecke des Wissens- und Technologietransfers. https://www.transferrallianz.de/fileadmin/user_upload/downloads/BMBF_Leitlinien_WTT-Ausgr%3%bcndungen.pdf
- Colombo MG, Piva E (2012) Firms' genetic characteristics and competence-enlarging strategies: a comparison between academic and non-academic high-tech start-ups. *Res Policy* 41:79–92. <https://doi.org/10.1016/j.respol.2011.08.010>
- Corbin J, Strauss A (2015) Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory (4th revised edition). SAGE Publications Inc
- Coupet J, Dickens A (2024) Is there a public innovation gap? Evidence from technology transfer. *J Technol Transf*. <https://doi.org/10.1007/s10961-024-10096-4>
- Deutsches Krebsforschungszentrum (2016) Guidelines for supporting German Cancer Research Centre (DKFZ) employees in spin-offs. <https://www.dkfz.de/en/techtrans/downloads/guides-policies/Spin-off-Companies.pdf>
- Doran P, Thomson R, Webster E (2024) When royalties impede technology transfer. *J Technol Transf*. <https://doi.org/10.1007/s10961-024-10095-5>
- Etzkowitz H (2004) The evolution of the entrepreneurial university. *Int J Technol* 1:64–77. <https://doi.org/10.1504/IJTG.2004.004551>
- Feldman M, Feller I, Bercovitz J, Burton R (2002) Equity and the technology transfer strategies of American Research Universities. *Manage Sci* 48:105–121. <https://doi.org/10.1287/mnsc.48.1.105.14276>
- Fini R, Fu K, Mathisen MT, Rasmussen E, Wright M (2017) Institutional determinants of university spin-off quantity and quality: a longitudinal, multilevel, cross-country study. *Small Bus Econ* 48:361–391. <https://doi.org/10.1007/s11187-016-9779-9>
- Fini R, Rasmussen E, Siegel D, Wiklund J (2018) Rethinking the commercialization of Public Science: from entrepreneurial outcomes to societal impacts. *Acad Manag Perspect* 32:4–20. <https://doi.org/10.5465/amp.2017.0206>

- Finì R, Rasmussen E, Wiklund J, Wright M (2019) Theories from the lab: how Research on Science Commercialization can contribute to Management studies. *J Manag Stud* 56:865–894. <https://doi.org/10.1111/joms.12424>
- Fontes M (2005) The process of transformation of scientific and technological knowledge into economic value conducted by biotechnology spin-offs. *Technovation* 25:339–347. <https://doi.org/10.1016/j.technovation.2003.08.004>
- Fraunhofer Venture Ausgründungs- und Beteiligungsstrategie der Fraunhofer-Gesellschaft. https://www.fraunhoferventure.de/content/dam/venture/de/documents/Angebote/SonstigeAngebote/Ausgruendung_s-und_Beteiligungsstrategie/Brosch%C3%BCre%20Ausgr%C3%BCndungsstrategie.pdf
- Geuna A, Rossi F (2011) Changes to university IPR regulations in Europe and the impact on academic patenting. *Res Policy* 40:1068–1076. <https://doi.org/10.1016/j.respol.2011.05.008>
- Giannopoulou E, Barlatier PJ, Pénin J (2019) Same but different? Research and technology organizations, universities and the innovation activities of firms. *Res Policy* 48:223–233. <https://doi.org/10.1016/j.respol.2018.08.008>
- Gilain A, Le Masson P, Weil B, Jibet N, Akinin P, Bekhradi A, Labrogere P (2022) Strengthening the generative power of a scientific and industrial ecosystem: the case of the SystemX Institute for Technological Research (IRT), a double impact Research and Technology Organization (RTO)? EURAM - European Academy of Management (Chair). EURAM - European Academy of Management, Zurich, Switzerland
- Gioia DA, Corley KG, Hamilton AL (2013) Seeking qualitative rigor in Inductive Research. *Organ Res Methods* 16:15–31. <https://doi.org/10.1177/1094428112452151>
- Godfrey PC, Allen GN, Benson D (2020) The biotech living and the walking dead. *Nat Biotechnol* 38:132–141. <https://doi.org/10.1038/s41587-019-0399-1>
- Gómez Gras JM, Galiana Lapera DR, Mira Solves I, Verdú Jover AJ, Sancho Azuar J (2008) An empirical approach to the organisational determinants of spin-off creation in European universities. *Int Entrepreneurship Manag* 4:187–198. <https://doi.org/10.1007/s11365-007-0061-0>
- Gómez Uranga M, Kerexeta E, G., Campàs-Velasco J (2007) The dynamics of commercialization of scientific knowledge in Biotechnology and Nanotechnology. *Eur Plan Stud* 15(9):1199–1214. <https://doi.org/10.1080/09654310701529136>
- Grimaldi R, Kenney M, Siegel DS, Wright M (2011) 30 years after Bayh–Dole: reassessing academic entrepreneurship. *Res Policy* 40:1045–1057. <https://doi.org/10.1016/j.respol.2011.04.005>
- Grimpe C, Fier H (2010) Informal university technology transfer: a comparison between the United States and Germany. *J Technol Transf* 35:637–650. <https://doi.org/10.1007/s10961-009-9140-4>
- Haeussler C, Harhoff D, Mueller E (2014) How patenting informs VC investors— the case of biotechnology. *Res Policy* 43:1286–1298. <https://doi.org/10.1016/j.respol.2014.03.012>
- Helmholtz Association of German Research Centres (2021): Transfer zwischen Forschung und Anwendung. Transfermission und -strategie der Zentren der Helmholtz-Gemeinschaft. https://www.helmholtz.de/assets/helmholtz_gemeinschaft/user_upload/Helmholtz_Transferstrategie_05Nov21_web.pdf
- Hemer J, Dornbusch F, Kulicke M, Wolf B (2010) Beteiligungen Von Hochschulen an Ausgründungen. Kurzfassung zum Endbericht für das Bundesministerium für Wirtschaft und Technologie (BWMi) <https://publica.fraunhofer.de/handle/publica/294946>
- Hertzfeld HR, Link AN, Vonortas NS (2006) Intellectual property protection mechanisms in research partnerships. *Res Policy* 35:825–838. <https://doi.org/10.1016/j.respol.2006.04.006>
- Howells J (2006) Intermediation and the role of intermediaries in innovation. *Res Pol* 35:715–728. <https://doi.org/10.1016/j.respol.2006.03.005>
- Hyytinen A, Väänänen L (2006) Where do Financial constraints Originate from? An empirical analysis of adverse selection and Moral Hazard in Capital Markets. *Small Bus Econ* 27:323–348. <https://doi.org/10.1007/s11187-005-0610->
- Jensen R, Thursby M (2001) Proofs and prototypes for sale: the licensing of University inventions. *Am Econ Rev* 91:240–259. <https://doi.org/10.1257/aer.91.1.240>
- Kenney M, Patton D (2011) Does inventor ownership encourage university research-derived entrepreneurship? A six university comparison. *Res Policy* 40:1100–1112. <https://doi.org/10.1016/j.respol.2011.05.012>
- Kim J, Daim TU (2014) A new approach to measuring time-lags in technology licensing: study of U.S. academic research institutions. *J Technol Transf* 39:748–773. <https://doi.org/10.1007/s10961-013-9327-6>
- Krumpal I (2013) Determinants of social desirability bias in sensitive surveys: a literature review. *Qual Quant* 47:2025–2047. <https://doi.org/10.1007/s11135-011-9640-9>

- Kulicke M (2023a) Internationale Praxis im Umgang mit IP-basierten Internationale Praxis im Umgang mit IP-basierten Ausgründungen aus Wissenschaftseinrichtungen und Vergleich mit der Situation in Deutschland: Aufbereitung aktueller Studien und Datenbestände <https://doi.org/10.24406/publica-3567>
- Kulicke M (2023b) Spin-offs aus Hochschulen Und Forschungseinrichtungen in Deutschland Und Weiteren Ländern: Aufbereitung Aktueller Studien Und Datenbestände Zum Forschungsumfeld. der jährlichen Zahl an Spin-offs und Beteiligungen ihrer Herkunftseinrichtungen <https://doi.org/10.24406/publica-3568>
- Lockett A, Wright M (2005) Resources, capabilities, risk capital and the creation of university spin-out companies. *Res Policy* 34:1043–1057. <https://doi.org/10.1016/j.respol.2005.05.006>
- Macho-Stadler I, Pérez-Castrillo D (2010) Incentives in university technology transfers. *Int J Ind Organ* 28:362–367. <https://doi.org/10.1016/j.ijindorg.2010.02.009>
- Markman GD, Gianiodis PT, Phan PH, Balkin DB (2005a) Innovation speed: transferring university technology to market. *Res Policy* 34:1058–1075. <https://doi.org/10.1016/j.respol.2005.05.007>
- Markman GD, Phan PH, Balkin DB, Gianiodis PT (2005b) Entrepreneurship and university-based technology transfer. *J Bus Ventur* 20:241–263. <https://doi.org/10.1016/j.jbusvent.2003.12.003>
- Max Planck Innovation GmbH (2016) Connecting Science and Business. https://www.max-planck-innovation.de/max-planck-innovation.html?file=files/Downloads/MI-broschuere_web.pdf%26cid=1887
- Max Planck Innovation GmbH Framework conditions for spin-offs. <https://www.max-planck-innovation.com/spin-off/framework-conditions-for-spin-offs.html>
- Mees-Buss J, Welch C, Piekkari R (2022) From templates to Heuristics: how and why to move beyond the Gioia Methodology. *Organ Res Methods* 25:405–429. <https://doi.org/10.1177/1094428120967716>
- Meuser M, Nagel U (2009) Das Experteninterview — Konzeptionelle Grundlagen und methodische anlage. In: Pickel S, Pickel G, Lauth H-J, Jahn D (eds) *Methoden Der Vergleichenden Politik- Und Sozialwissenschaft*. VS Verlag für Sozialwissenschaften, pp 465–479. https://doi.org/10.1007/978-3-531-91826-6_23
- Misoch S (2019) *Qualitative interviews (2., erweiterte und aktualisierte auflage)*. De Gruyter Studium. De Gruyter Oldenbourg <https://doi.org/10.1515/9783110545982>
- Munari F, Rasmussen E, Toschi L, Villani E (2016) Determinants of the university technology transfer policy-mix: a cross-national analysis of gap-funding instruments. *J Technol Transf* 41:1377–1405. <https://doi.org/10.1007/s10961-015-9448-1>
- O'Shea RP, Allen TJ, Chevalier A, Roche F (2005) Entrepreneurial orientation, technology transfer and spinoff performance of U.S. universities. *Res Policy* 34:994–1009. <https://doi.org/10.1016/j.respol.2005.05.011>
- Perkmann M, Salandra R, Tartari V, McKelvey M, Hughes A (2021) Academic engagement: a review of the literature 2011–2019. *Res Pol* 50:104114. <https://doi.org/10.1016/j.respol.2020.104114>
- Philpott K, Dooley L, O'Reilly C, Lupton G (2011) The entrepreneurial university: examining the underlying academic tensions. *Technovation* 31:161–170. <https://doi.org/10.1016/j.technovation.2010.12.003>
- Powers JB, McDougall PP (2005) University start-up formation and technology licensing with firms that go public: a resource-based view of academic entrepreneurship. *J Bus Ventur* 20:291–311. <https://doi.org/10.1016/j.jbusvent.2003.12.008>
- Pratt MG (2009) From the editors: for the lack of a Boilerplate: Tips on writing up (and reviewing) qualitative research. *Acad Manag Jour* 52:856–862. <https://doi.org/10.5465/amj.2009.44632557>
- Rasmussen E, Borch OJ (2010) University capabilities in facilitating entrepreneurship: a longitudinal study of spin-off ventures at mid-range universities. *Res Policy* 39:602–612. <https://doi.org/10.1016/j.respol.2010.02.002>
- Rasmussen E, Wright M (2015) How can universities facilitate academic spin-offs? An entrepreneurial competency perspective. *J Technol Transf* 40:782–799. <https://doi.org/10.1007/s10961-014-9386-3>
- Savva N, Taneri N (2015) The role of Equity, Royalty, and fixed fees in Technology Licensing to University spin-offs. *Manage Sci* 61:1323–1343. <https://doi.org/10.1287/mnsc.2014.2000>
- Shen H, Coreynen W, Huang C (2022) Exclusive licensing of university technology: the effects of university prestige, technology transfer offices, and academy-industry collaboration. *Res Policy* 51. <https://doi.org/10.1016/j.respol.2021.104372>
- Siegel DS (2011) *The rise of University Technology Transfer and academic entrepreneurship: managerial and policy implications*. In: Audretsch DB, Falck O, Heblich S, Lederer A (eds) *Handbook of Research on Innovation and Entrepreneurship*. Edward Elgar Publishing. <https://doi.org/10.4337/9781849807760.00028>

- Siegel D, Bogers M, Jennings P, Xue L (2023) Technology transfer from national/federal labs and public research institutes: managerial and policy implications. *Res Policy* 52. <https://doi.org/10.1016/j.respol.2022.104646>
- Slavtchev V, Göktepe-Hultén D (2016) Support for public research spin-offs by the parent organizations and the speed of commercialization. *J Technol Transf* 41:1507–1525. <https://doi.org/10.1007/s10961-015-9443-6>
- Tracey I, Williamson A (2023) Independent review of university spin-out companies. Final report and recommendations. Department for Science, Innovation and Technology; HM Treasury https://assets.publishing.service.gov.uk/media/6549fcb23ff5770013a88131/independent_review_of_university_spin-out_companies.pdf
- Woolley JL (2017) Origins and outcomes: the roles of spin-off founders and intellectual property in high-technology Venture outcomes. *Acad Manag Discov* 3:64–90. <https://doi.org/10.5465/amd.2014.0138>
- Wright M, Lockett A, Clarysse B, Binks M (2006) University spin-out companies and venture capital. *Res Policy* 35:481–501. <https://doi.org/10.1016/j.respol.2006.01.00>
- Wright M, Clarysse B, Lockett A, Knockaert M (2008) Mid-range universities' linkages with industry: knowledge types and the role of intermediaries. *Res Policy* 37:1205–1223. <https://doi.org/10.1016/j.respol.2008.04.021>

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